NETS SQSS Review

Industry Review Group

Wind Criteria Workshop

Agenda

- Introductions
- Existing SQSS Criteria
- GSR001 & SQSS Fundamental Review
- Dual Criteria
- UK Wind Characteristics
- Demand Security Criterion
- Deterministic vs. Cost Benefit Analysis Criteria
- Development of a Wind Integration Criterion
- Questions

Existing SQSS Procedure (Pre-Wind)

- Dual role in ensuring transmission:
  - Does not unduly restrict generation in securing demand
  - Does facilitate market operation
- Peak demand security
- Year round requirements
- Minimum transmission identified
- CBA used to justify additional transmission

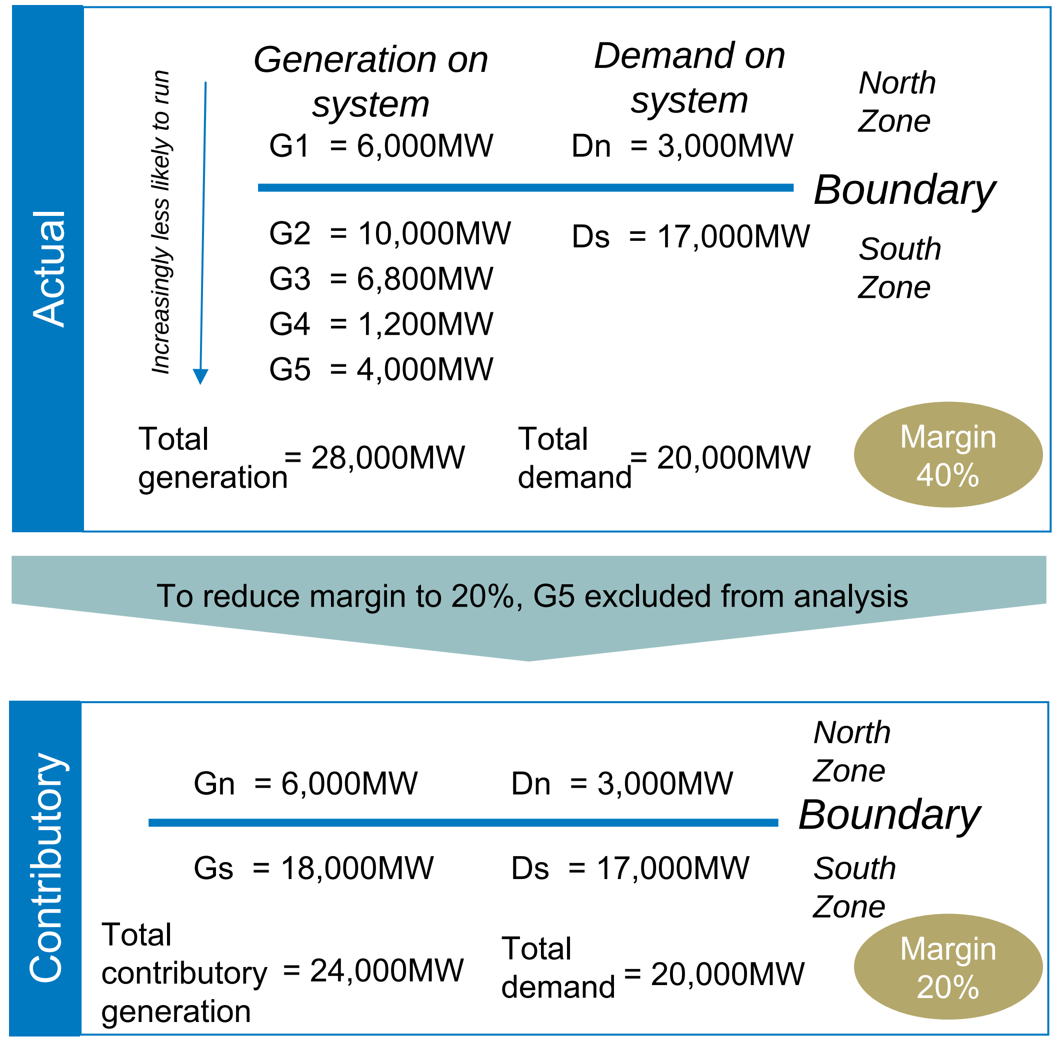
Existing SQSS Procedure (Pre-Wind)

Required transfer capability	=	Planned transfer	+	Interconnection allowance

• Total transmission capability for each boundary		• Defines required MW transfer across boundaries to meet peak demand given assumptions on generation operating to meet this peak demand		• Additional MW transfer capability across boundaries
				• Required to:
				  ◦ "ensure that transmission does not unduly restrict generation from contributing to demand security"; and / or
				  ◦ account for "non average conditions

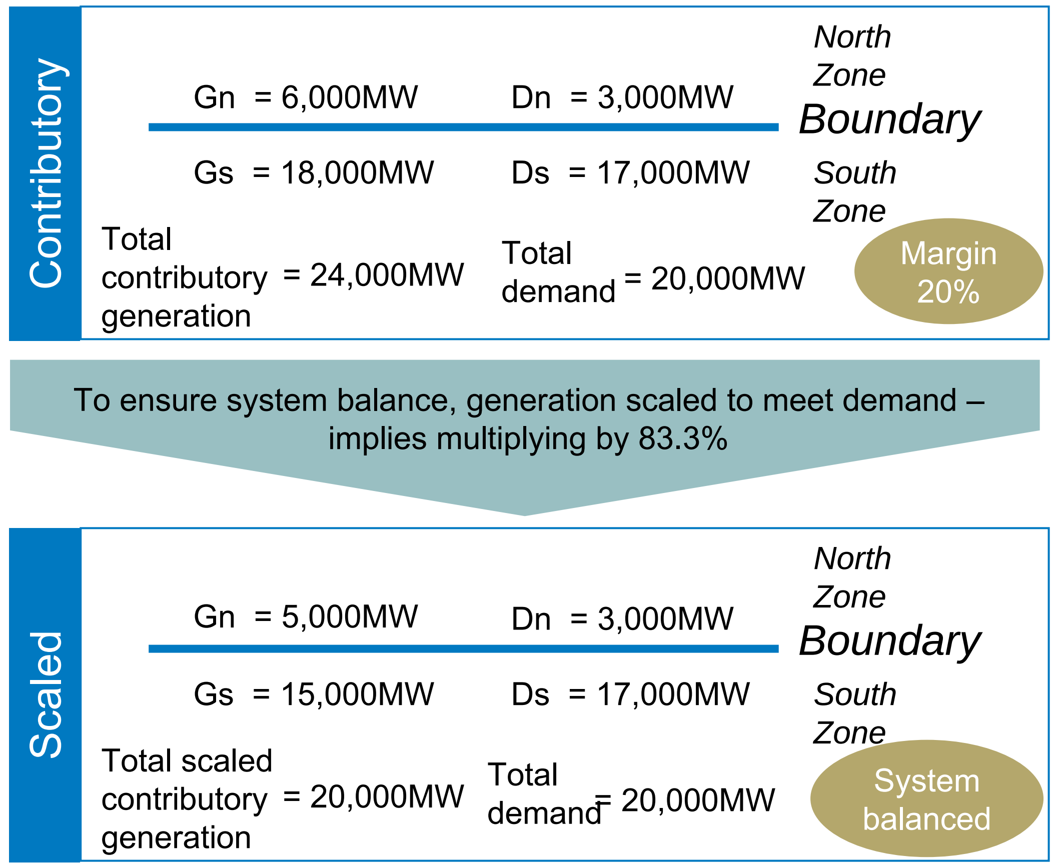
Planned transfer: Step 1 – Calculate contributory generation

- Contributory generation is calculated to be 120% of system peak demand.
- 20% plant margin based on historically observed plant margin – allows for some plant to be unavailable at system peak with maintenance of appropriate demand security
- Generation across system is ranked. Those considered “least likely to run” ranked at bottom of list
- Plant at bottom of rank not needed to meet 20% plant margin excluded from assessment of planned transfer
- Remaining plant used to assess transmission needs



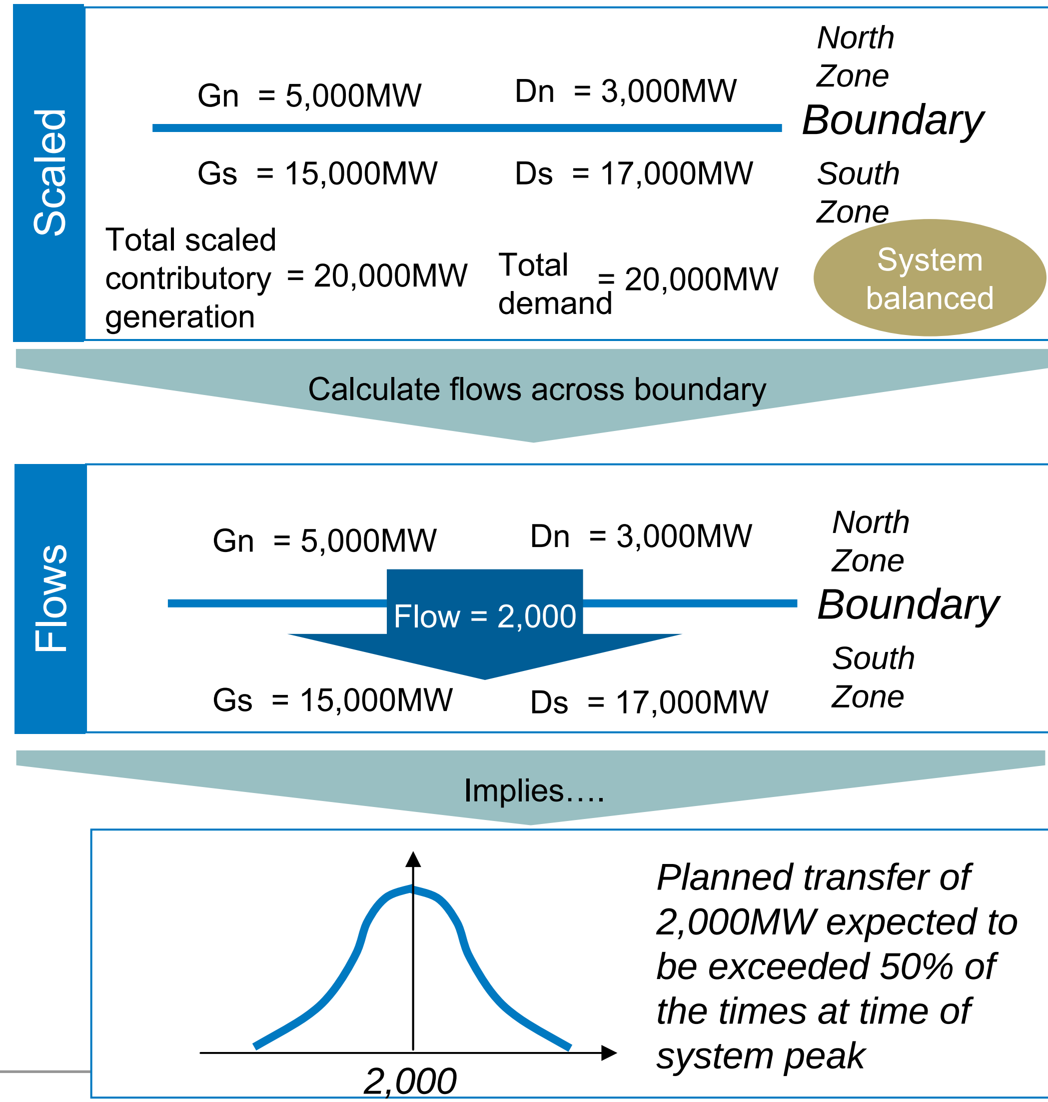
Planned transfer: Step 2 - Scale back generation

- To assess planned transfer need to make sure system balances…
- .. therefore scale back generation uniformly across system until demand and generation met .
- Implies that (absent wind and with 20% margin assumption) that generation will always be scaled back to 83.3% (i.e. 1/1.2)



Planned transfer: Step 3 - calculate flows

- On basis of dispersion of scaled back contributory generation can assess flows at system peak demand
- Simply the difference between generation and demand in each zone
- Planned transfer condition expected to be exceeded 50% of time at peak
- Designing to planned transfer would restrict generation in meeting demand



Interconnection allowance: Step 1 – define smaller area and calculate "X axis" value

- Scaled contributory generation and demand is summed
- Smaller area is defined as lowest summed generation and demand across a boundary
- X axis value is calculated as sum of scaled contributory generation and demand divided by twice peak demand

Scaled

North Zone

Gn = 5,000MW   Dn = 3,000MW

Boundary

Gs = 15,000MW   Ds = 17,000MW

South Zone

Total scaled contributory generation = 20,000MW   Total demand = 20,000MW

System balanced

Define smaller area and calculate x axis value

X axis

- North is smaller area (8,000MW vs 32,000)
- X axis value = 8,000MW / (2*20,000)MW = 20%

Interconnection allowance: Step 2 - Use “Circle diagram” to assess interconnection allowance

- Use “circle diagram” to assess y axis value
- Derive interconnection allowance which is a function of peak demand
- IA is halved for boundaries that meet N – 2 security

X axis

- North is smaller area (8,000MW vs 32,000)
- X axis value = 8,000MW / (2*20,000MW) = 20%

Calculate y axis value

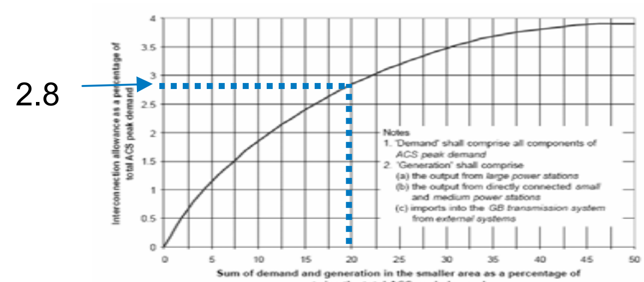


Figure A 3. The 'circle diagram' [source: GB SQSS version 1.0 Appendix D]

- X – axis 20% converts to Y axis value of 2.8%(ish)
- Implies interconnection allowance of 560MW
- Assume boundary is N – 2 security standard. Implies IA of 280 MW

Would imply an overall required transfer capability of 2,280MW

Development of Wind Integration Criteria

- GSR001 in 2007-2008
- SQSS Fundamental Review 2008-ongoing
- Establishment of dedicated SQSS wind integration working group in March 2010
- Aim to consult on proposals June 2010
- Report to Ofgem mid-July 2010

GSR001 - Review for Onshore Intermittent Generation

Offshore wind was excluded

- Ongoing offshore work
- Different view on offshore volumes

Approaches considered

1a Current method with wind A_T = 72%

1b Current method with wind A_T = 72% / 5%

2. Security (ΔLOLP)
3. Demand security "Membranes"
4. "Equal access"
5. Economic approach

GSR001 Proposals

- Broadly proposed to retain current process
  - Robustness
  - Simplicity
  - Continuity
  - Transparency
- Retain current level of security provided by transmission
- Variant of current process (Approach 1b) proposed
  - 5% wind scaling factor in importing areas
  - 72% wind scaling factor in exporting areas
- Retain the framework of a central deterministic approach supplemented by cost-benefit appraisal if appropriate
- Clarification on application of cost-benefit appraisal
  - Key variables: Size of reinforcement, number of seasons, generation and demand backgrounds, demand blocks, generation ranking and availability, network boundary capability, etc

GSR001 Consultation Responses

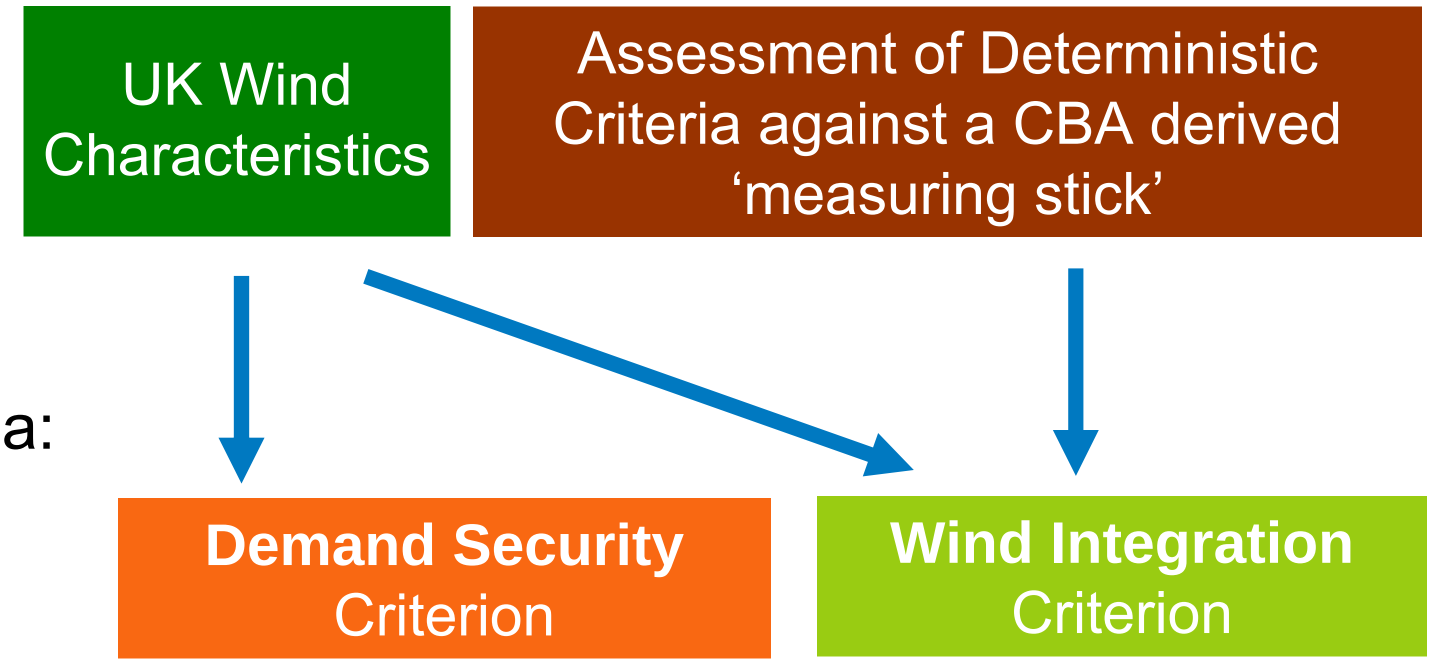
- Justification for wind A_T factors was considered weak
  - Little support for options 1a and 1b.
- Support for approaches 3 and particularly 4 (“equal access”)
  - Many wanted GSR001 to wait until this work was completed.
- Not much support for pure economics
  - Awareness of the complexity and difficulty of this.
- Support for “transmission sharing" concept
- Support for SEDG proposals
  - Not part of GSR001, but taken forward in Fundamental Review
- Concern about interaction with TAR

SQSS Fundamental Review

- Issue fell within the remit of Working Group 3
- Breadth of WG3's scope hindered progress on this specific aspect
- Recognition of increasing volume of wind applying for connection to the system resulted in establishment of this dedicated working group
- Remaining issues within Working Group 3's wider remit will continue to be analysed later in 2010

Recent & Ongoing Assessment

- Two streams of analysis:



- Dual criteria:

Dual Criteria

- SQSS has dual goal of ensuring the transmission system
  - does not unduly restrict generation in securing demand
  - does facilitate market operation

- Previous proposals (i.e. 72%/5%) have sought to simultaneously ensure both in a single criterion – simplified solution to get to CBA answer

  → Confusion

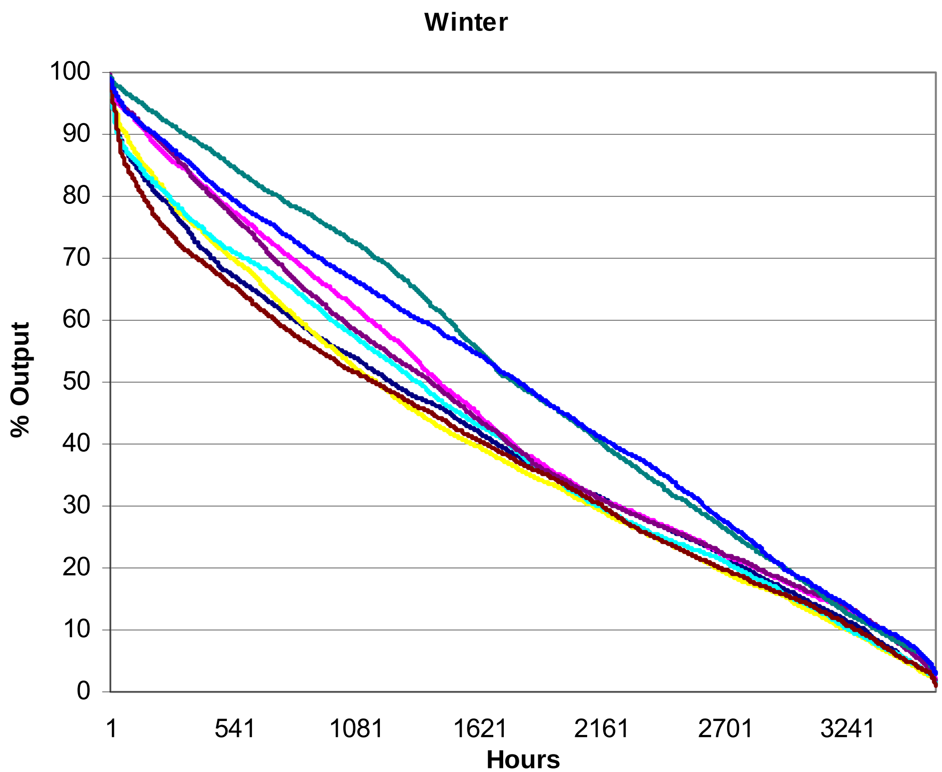
- Now proposing separate ‘demand security’ criterion

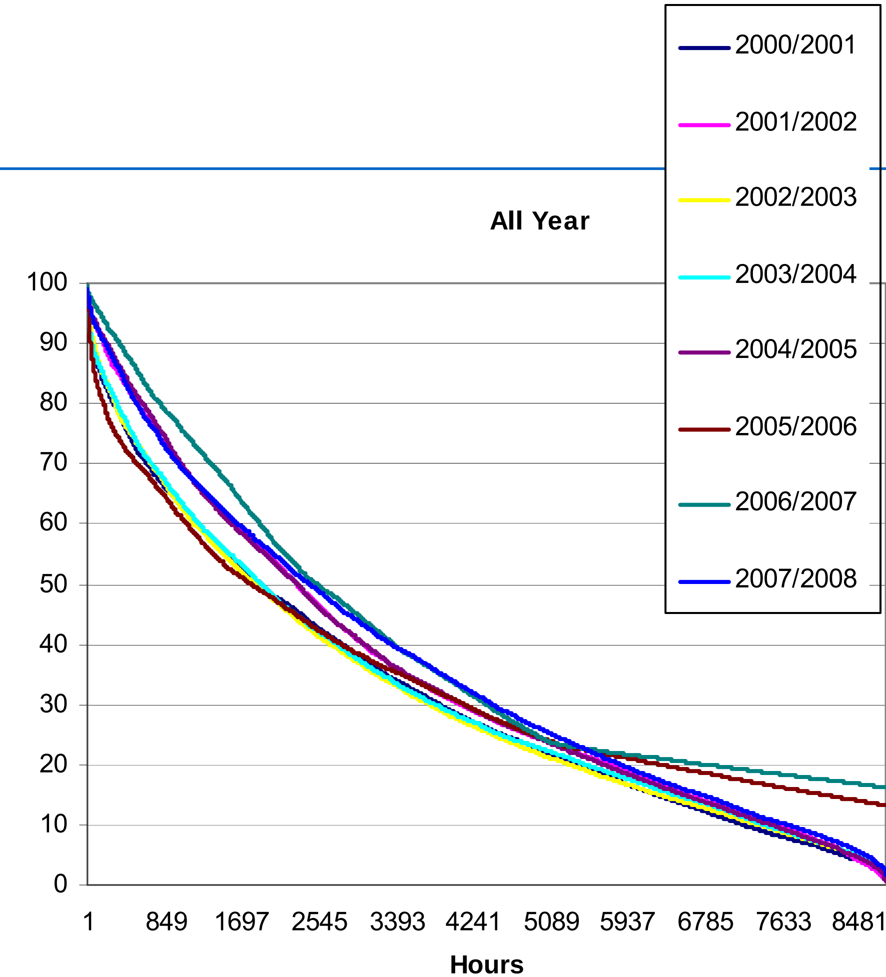
Analysis of UK Wind Characteristics

Analysis of wind data compiled by Poyry:

- Hourly capacity factor data from 36 wind measurement sites throughout Britain and Ireland from 2000 through to 2007.
- Includes on & off-shore locations
- Data adjusted to account for turbine hub height
- Wind farm locations/capacities as per Gone Green 2030 scenario.

Wind Availability





On average, generation is above..	40% of Rated Output	60% of Rated Output
Throughout Winter	50.3% of the time	28.8% of the time
Throughout Entire Year	33.0% of the time	16.4% of the time

Regional Wind Correlation

- Regional differences in wind generation significantly affect the requirement for transmission reinforcement.

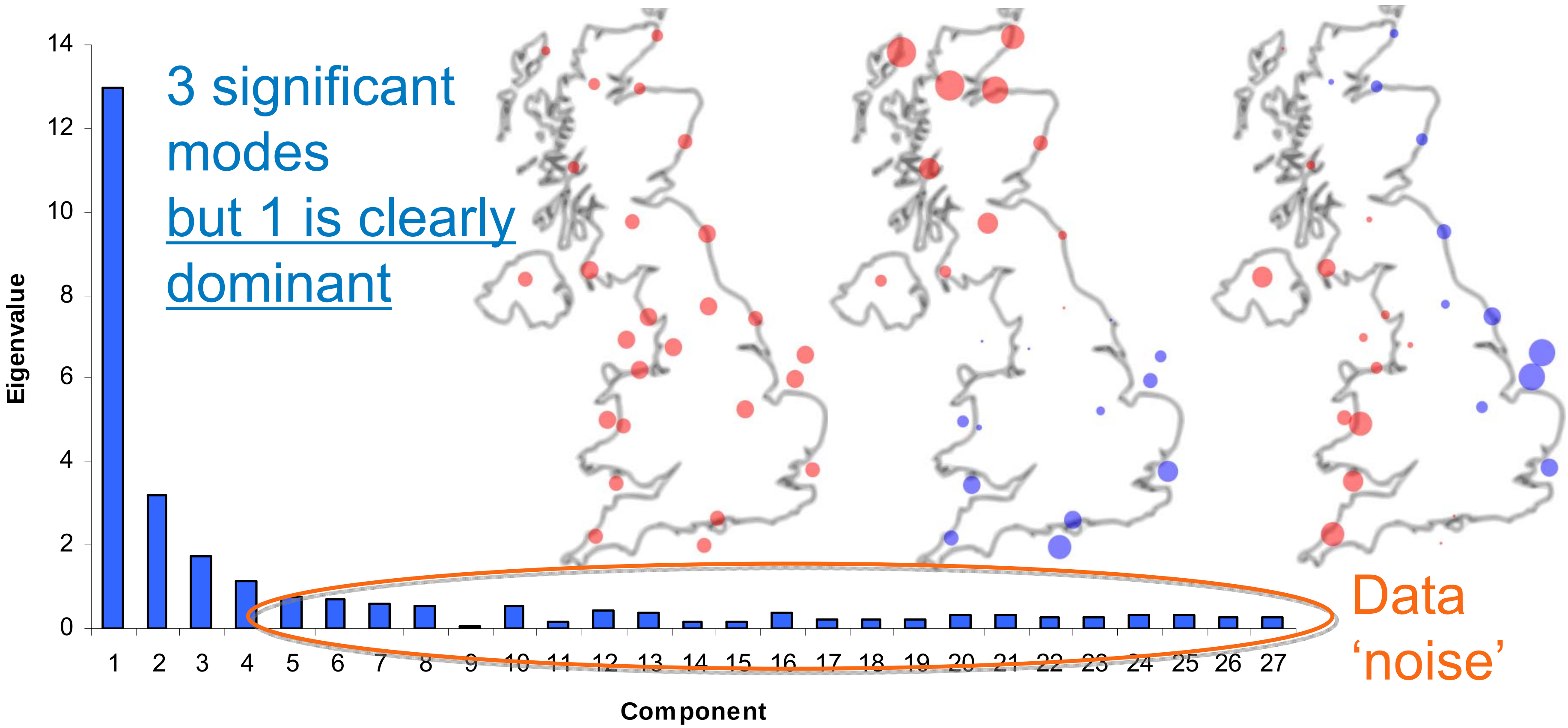
		England										
		0-10%	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	**Totals**
Scotland	0-10%	9.20%	6.12%	4.73%	2.78%	1.45%	0.86%	0.56%	0.32%	0.14%	0.09%	26.25%
	10-20%	4.70%	5.12%	3.54%	2.66%	1.80%	1.28%	0.89%	0.67%	0.33%	0.27%	21.25%
	20-30%	1.90%	2.96%	2.62%	2.01%	1.51%	1.22%	0.89%	0.71%	0.45%	0.34%	14.61%
	30-40%	0.93%	1.76%	1.58%	1.46%	1.09%	1.01%	0.87%	0.86%	0.59%	0.48%	10.62%
	40-50%	0.55%	1.05%	0.95%	0.95%	0.97%	0.95%	0.90%	0.72%	0.67%	0.59%	8.30%
	50-60%	0.28%	0.55%	0.65%	0.76%	0.70%	0.77%	0.71%	0.66%	0.64%	0.72%	6.43%
	60-70%	0.10%	0.35%	0.39%	0.54%	0.46%	0.60%	0.59%	0.55%	0.67%	0.82%	5.06%
	70-80%	0.06%	0.17%	0.21%	0.28%	0.28%	0.34%	0.49%	0.48%	0.51%	0.88%	3.71%
	80-90%	0.02%	0.06%	0.09%	0.11%	0.14%	0.21%	0.26%	0.35%	0.46%	1.00%	2.70%
	90-100%	0.00%	0.01%	0.02%	0.06%	0.05%	0.07%	0.09%	0.10%	0.19%	0.50%	1.08%
	Totals	17.73%	18.13%	14.77%	11.61%	8.46%	7.31%	6.25%	5.41%	4.64%	5.69%	

- Significant alignment of wind generation in Scotland with wind generation in England and Wales → little diversity

Regional Wind Correlation

- Another view…

1.Same Everywhere **12.3** | 2. North/South Difference **3.16** | 3. East/West Difference **1.76**



Demand Security Criterion

- Wind generation cannot contribute significantly to demand security:
  - Low & intermittent capacity factor
  - Significant wind correlation throughout Great Britain
- Propose use of separate demand security criterion that assumes a low/zero contribution from intermittent generation (where intermittent generation = wind, wave, tidal)
- Not expected to drive transmission reinforcement on most boundaries

Proposed Demand Security Criterion

- **Set all intermittent generation in GB to zero output,** then:
  - If remaining plant margin exceeds 120%, apply the ranking process to set some non-contributory
  - Otherwise, all non-intermittent generation is considered contributory
  - Scale contributory generation to ACS demand*
  - Add ½ Interconnection Allowance (IA) / full IA

Existing Process

* Allow the scaling factor to exceed 100% if generation is insufficient to meet demand. This implicitly assumes new generation build, distributed pro-rata around the country.

Proposed Demand Security Criterion

- In all published NG scenarios from 2005-2030, the proposed criterion requires a much lower boundary capability than a ‘high wind’ criterion for most SYS boundaries
- The criterion is most relevant to the importing boundaries within south-west England (SYS boundaries B10, B12, B13)
- It is recognised that zero wind is a slightly extreme case, but there is little point agonising whether to use ~3% or ~5% etc. Since only ~2GW of wind is expected in SW England, and so the boundary requirement will only be affected by 50-100MW; insignificant given the scale of transmission reinforcements

Wind Integration Criterion

- To provide the appropriate level of transmission to minimise the net cost of transmission reinforcement and market operation, year-round, in a system with significant volumes of intermittent (especially wind) generation.

Cost-Benefit Approach – Features

- We are talking about an Economic Appraisal, which is Probabilistic on the within-year operating conditions only
  - We are not talking Probabilistic on Gen / Dem = Planning Backgrounds
- Traditional Exposition of the Probabilistic Approach is merely a cost-benefit test, viz: 'One assesses a particular reinforcement proposal against the base-case of current system = Do-Nothing'
  - We do not see a detailed method, that comes up with some sort of 'required capability'
  - So a cost-benefit may not support any concept of 'a compliant network'; all one can say is 'we cannot identify any economic reinforcement'

Cost-Benefit Approach – Merits

- Cost-Benefit PROs:
  - Directly reflects the underlying economics of transmission
  - Is always debated, in detailed assessments of major new transmission
- Cost-Benefit CONs:
  - Depends on a host of input data values
  - Eg: Conventional gen availability; Wind availability; Merit order, year-round; Seasonal transmission capabilities; Transmission Outage rate; Bid and Offer prices; Availability and Price of inter-trips and other post-fault measures
  - As a result, typically non-transparent
  - Likely to be inconsistent over time
  - Analysis takes longer and is more labour intensive
  - Difficult for Scottish TOs to apply, who do not access GBSO data
  - Extremely difficult for us to determine how users will value transmission in the future, we can only note how they valued it in the past

Sensitivity of Cost-Benefit Approach

- GG5c 2020 Required Capabilities:

Boundary	Existing (MW)	Base Case	BDGKM	CN
B6	2200	6910	4860	8020
B7a	3600	9630	6720	10680

B. Transmission price from 100 → 50 £/MW.km

D. Seasonal Capabilities 93% 85% 76% → 90% 80% 70% of Winter Capability

G. 1000MW of Peterhead from Baseload_Gas → Marginal_Gas

K. Reduce availability of Nuclear and CCGT by 5% (ie 90% / 85% → 85% / 80%)

M. South-North → North-South despatch within fuel-type

C. Bid-Offer differential +40%

N. Hydro undercuts France; and 1000MW of Longannet from Marginal_Coal to Baseload_Coal

Deterministic Approach – Merits

- Deterministic PROs:
  - Simply explained & can be applied transparently
  - Depends on a smaller number and variety of input data values
  - Will be consistent across years
  - Can be pragmatically applied by TOs
- Deterministic CONs:
  - Calibrated against a particular set of backgrounds
  - May not reflect the underlying economics
  - Some parameters are apparently arbitrary

Cost-Benefit vs Deterministic Conclusions

- Both approaches have significant strengths and weaknesses
- Therefore, the working group is minded to propose a hybrid solution that seeks to obtain the benefits whilst managing the weaknesses of each approach:
  - A deterministic wind integration criterion that transparently and defendably establishes a minimum boundary transfer capability.
  - Increased utilisation of detailed cost-benefit analysis to justify additional reinforcement of boundaries where specific circumstances support this

Proposed Wind Integration Deterministic Criterion

- A deterministic criterion to specify a conservative minimum boundary transfer capability, calibrated against a cost-benefit derived ‘measuring stick’
- Establishes a baseline which the industry can plan against and which will support the need-case for most transmission reinforcement as it progresses through the public consenting process.
- Calibration factors may need to be re-calibrated periodically to take account of changing circumstances and evolving future forecasts

Proposed Wind Integration Cost-Benefit Analysis

- Increased use of CBA to justify boundary transfer capability above the deterministic baseline
- May be value in expanding the guidelines for performing CBA to maximise the transparency of this process.

The Quest for a Deterministic Wind Integration Criterion

- The following slides describe the process used to identify the most appropriate deterministic rule. In general:
  1. Identify various deterministic rules and quantify the boundary capability they require for different boundaries
  2. Measure the operational and infrastructure costs associated with different transfer capabilities using CBA
  3. For each boundary, plot the required capabilities identified in step 1 with the costs determined in step 2
  4. Assess the various deterministic rules by their alignment of their results with the minimum-cost transfer capability
- Perform this exercise for 6 boundaries × 2 scenarios, × 3 years

1. Deterministic Rules

Fixed A_T	Variable A_T		
Single A_T	Exp. $A_T \neq$ Imp. A_T	Exp. A_T = Imp. A_T	
40% Contrib.	40% Contrib.		'Radical'
1a	1b	1d	1c

- Method 1a: traditional SQSS '60% / 60%'
  - Determine contributory / non-contributory as usual (Wind treated at 40%)
  - A_T for Wind = 0.72 on both export and import side
  - Scale generation to meet ACS demand
  - Add ½IA as usual
- Method 1b: lower Wind in import '60% / 5%'
  - As 1a, but set A_T = 0.05 / 0.15 / 0.25 / 0.35 (1b1 / 1b2 / 1b3 / 1b4) for Wind on import side

1. Deterministic Rules

- Method 1c1-1c3: non-ranking order:
  - 0. Set OCGTs, ~half pumped storage plus hydro non-contributory
  - 1c1. Apply At = 0.72 for intermittent; Scale all remaining capacity to peak demand.
  - 1c2. Apply At = 0.72 to intermittent; Fix Nuclear to 83% output; Scale all remaining capacity to peak demand.
  - 1c3. Fix Nuclear to 83% and Wind to 60%; Scale remaining non-intermittent capacity to peak demand.

	A_T Factor				Direct Scaling Factor			
Approaches	Intercon.	Nuclear	Renewable	Other (Non-Nuclear, Non-Renewable)	Intercon.	Nuclear	Renewable	Other (Non-Nuclear, Non-Renewable)
1c1	N/A	100%	72%	100%	100%	N/A	N/A	N/A
1c2	N/A	N/A	72%	100%	100%	83%	N/A	N/A
1c3	N/A	N/A	N/A	100%	100%	83%	60%	N/A

1. Deterministic Rules

- Method 1d:
  - Determine contributory / non-contributory as usual (Wind treated at 40%)
  - A_T for Wind is the same on both export and import side, but is set to a varying factor for each selected boundary
  - Scale generation to meet ACS demand
  - Add ½IA as usual

Approach	*Wind/Wave Contributory*	*Wind A_T Factor*	
		Importing groups	*Exporting groups*
1d - (B1, B15)	40%	90%	90%
1d - (B4, B6)		80%	80%
1d - (B7a)		70%	70%
1d - (B8, B9)		60%	60%

1. Deterministic Rules: Results

- For GG5a GG5c in 2015, only 11.3GW of Wind;
  - 4.8GW of plant is non-contributory
  - Hence scaling factor under 1a ends at 79%
  - Scaling factor under 1b1 ends at 82% for B6 and 81% for B9
  - Scaling factor under 1c3 is 75%
- For GG5a and GG5c in 2020, 29.4GW of Wind:
  - 7.8GW of plant is non-contributory
  - Hence scaling factor under 1a ends at 73%
  - Scaling factor under 1b1 ends at 86-90% for B6 and 79% for B9
  - Scaling factor under 1c3 is 61%

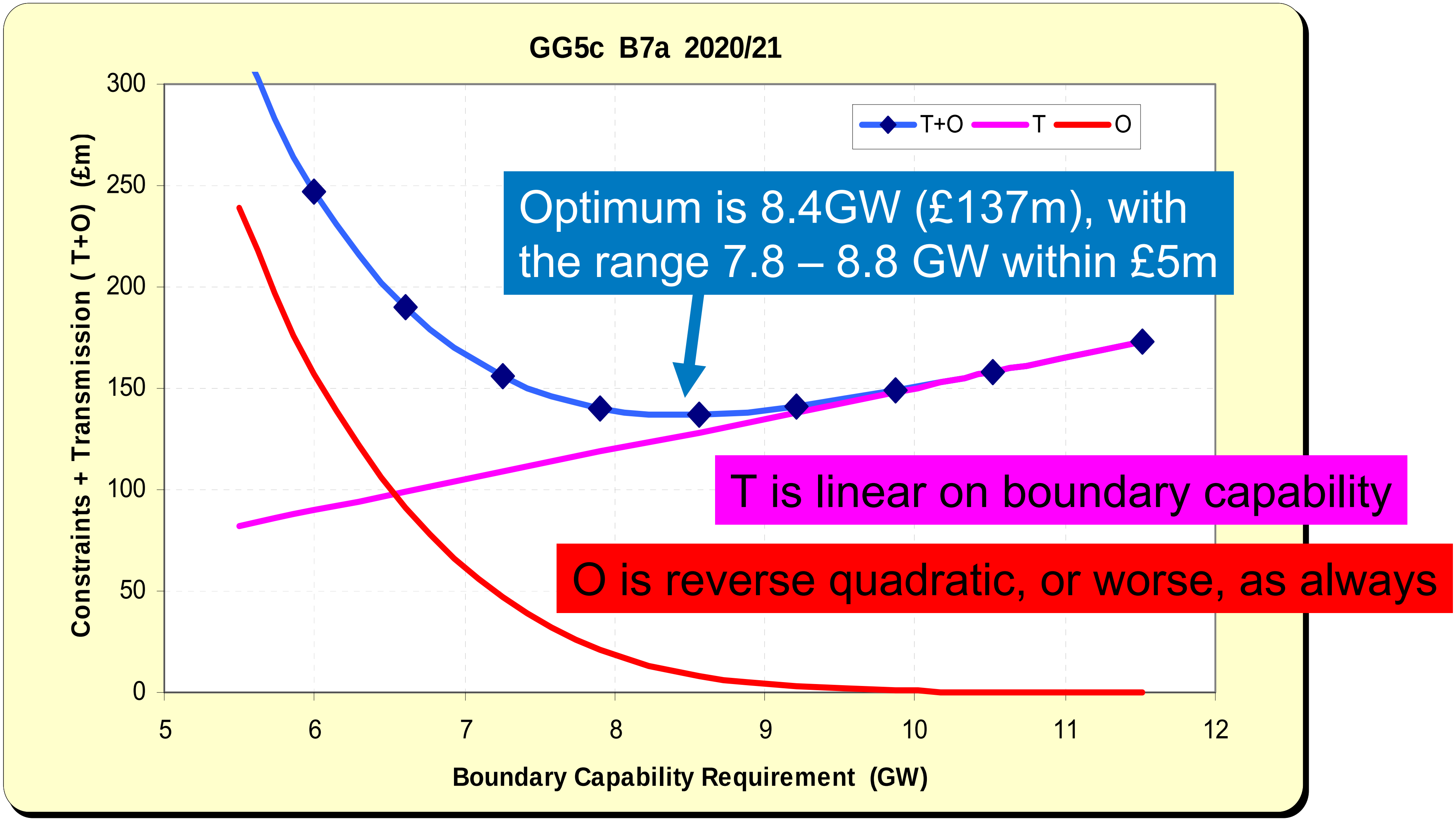
2. Economic Measuring Stick

- Backgrounds:
  - GG5a & GG5c (differ by 5GW Wind from Scotland to England)
  - Years 2015, 2020, 2030
- Transmission Price (T):
  - A ‘moderate’ 100 £/MW.km, × boundary thickness (often 100km)
- Boundary Capabilities (O):
  - Seven arbitrary winter capabilities studied, spanning from -0.25 to +1.25 of range of capabilities requires under 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 1d

2. Economic Measuring Stick

- Cost-Benefit parameters, as of the Dec08 ENSG study:
  - 3 seasons: winter (20 week) summer_intact (20 week) summer_outage (8 week)
  - Summer_intact capab = 0.85 × winter (4-6 cct boundary) = 0.9 × winter (>7 cct)
  - Summer_outage capab = 0.7 × winter (4-6 cct boundary) = 0.8 × winter (>7 cct)
  - Generator and Wind availabilities as Dec08
  - Merit Order as Dec08 viz, Base_Gas Base_Coal, Hydro, Marg_Gas, Marg-Coal
  - Bid Price = 0.5 × Fuel Price; Offer Price = 2.0 × Fuel Price

3. Assessment of Results — Illustration



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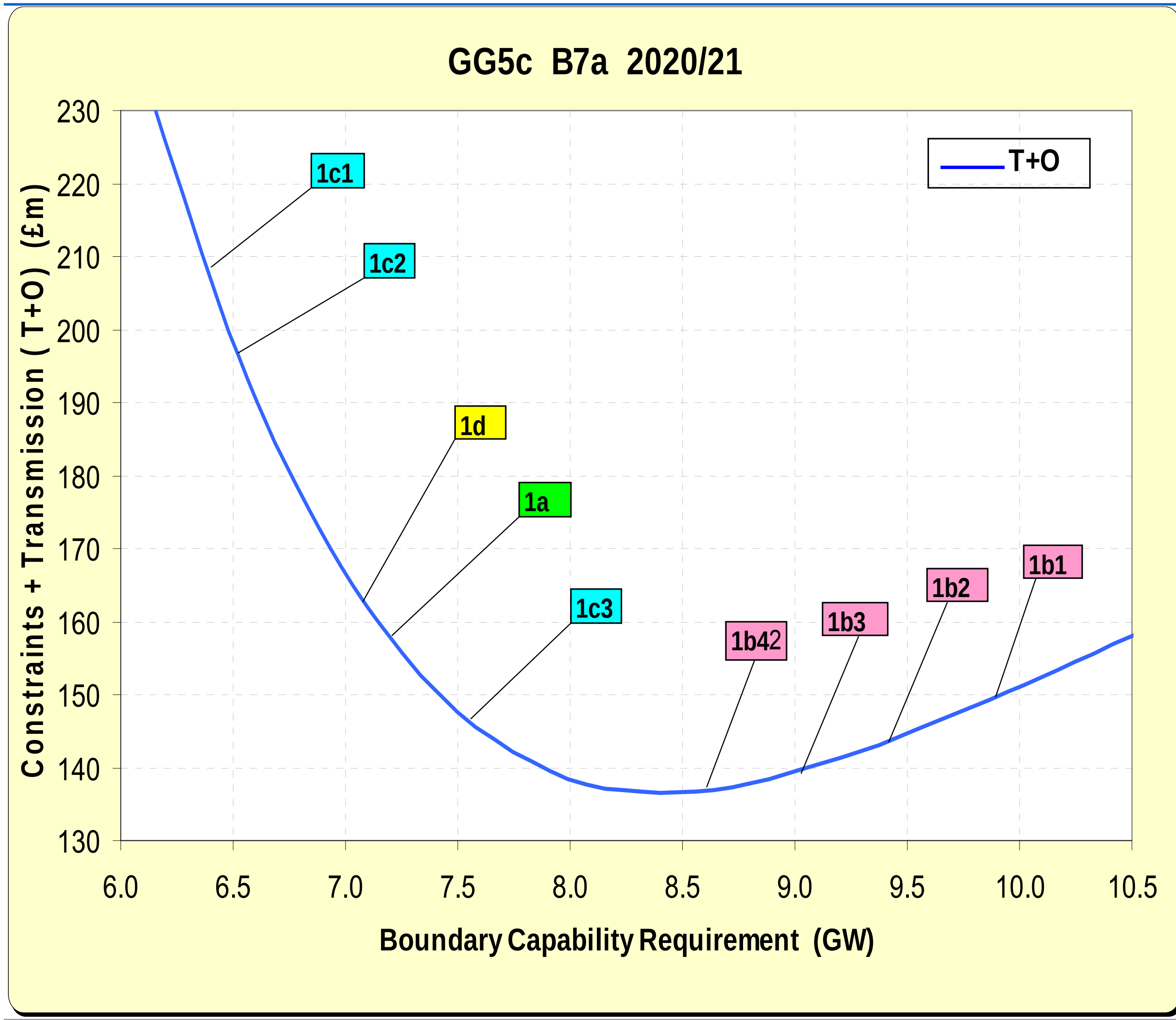


- In general, we always have:

1a < 1b4 < 1b3 < 1b2 < 1b1

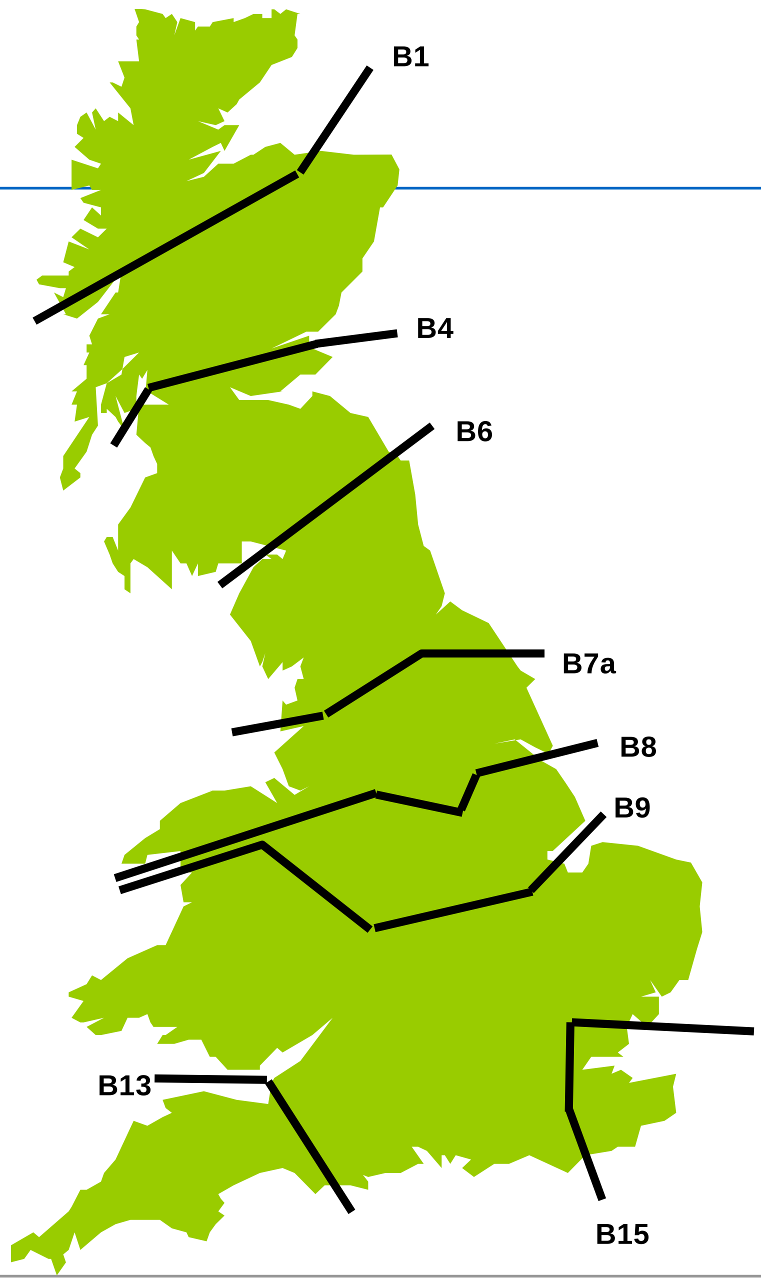
- 1c1-1c3 and 1d are usually close to 1a
- Here, 1a is 1.1GW and £16m *below* the optimum: 1b4 - 1b1 are 0.2 - 1.5GW and £0.5m - £14m *above* the optimum: 1c1 – 1c3 are 0.8 - 2.0GW and £10m - £76m *above* the optimum

Optimum points on the T+O Curve for 2020/21

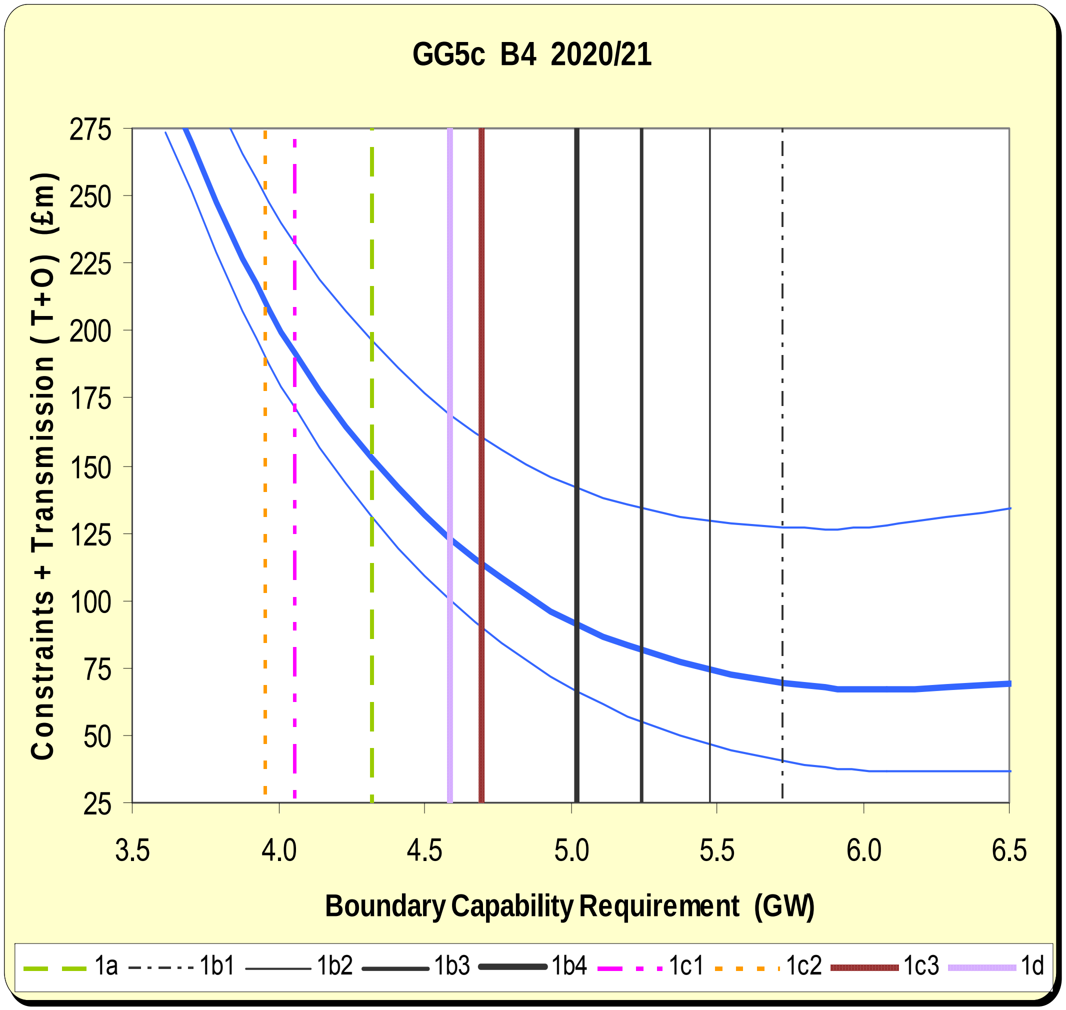
Boundary	Thickness (km)	Background		Ranking Order Approach						Non-Ranking Order Approach			Optimum	
				1a	1b1	1b2	1b3	1b4	1d	1c1	1c2	1c3	*GW T+O*	*Range*
B4	100	GG5a	GW	2.8	4.0	3.8	3.6	3.4	2.9	2.6	2.5	2.9	*4.1*	*3.6 - 4.8*
			T+O	£96m	£44m	£46m	£49.5m	£55m	£84m	£120m	£132m	£84m	*£44m*	*< £49m*
			Δ GW from Optimum	-1.3	-0.1	-0.3	-0.5	-0.7	-1.2	-1.5	-1.6	-1.2		
			Δ T+O from Optimum	£52m	£0m	£2m	£6m	£11m	£40m	£76m	£88m	£40m		
		GG5c	GW	4.3	5.7	5.5	5.2	5.0	4.6	4.1	4.0	4.7	*6.0*	*5.6 - 7.2*
			T+O	£152.5m	£69m	£74m	£82m	£91m	£125m	£194m	£212m	£114m	*£67m*	*< £72m*
			Δ GW from Optimum	-1.7	-0.3	-0.5	-0.8	-1.0	-1.4	-1.9	-2.0	-1.3		
			Δ T+O from Optimum	£86m	£2m	£7m	£15m	£24m	£58m	£127m	£145m	£47m		
B6	150	GG5a	GW	3.2	5.4	5.0	4.6	4.3	3.4	2.9	2.9	3.4	*4.6*	*3.9 - 5.2*
			T+O	£117m	£81m	£76.5m	£75m	£76m	£111m	£170m	£163m	£108m	*£74.5m*	*< £79.5m*
			Δ GW from Optimum	-1.4	0.8	0.4	0.0	-0.3	-1.2	-1.7	-1.7	-1.2		
			Δ T+O from Optimum	£43m	£7m	£2m	£1m	£2m	£36m	£96m	£89m	£34m		
		GG5c	GW	5.8	7.9	7.6	7.2	6.9	6.2	5.3	5.3	6.4	*8.0*	*7.3 - 8.8*
			T+O	£218m	£129m	£130.5m	£135.5m	£144.5m	£187.0m	£293m	£294m	£172m	*£129m*	*< £134m*
			Δ GW from Optimum	-2.2	-0.1	-0.4	-0.8	-1.1	-1.8	-2.7	-2.7	-1.6		
			Δ T+O from Optimum	£89m	£0m	£2m	£7m	£16m	£58m	£164m	£165m	£43m		
B7a	150	GG5a	GW	4.7	7.7	7.1	6.7	6.2	4.6	4.0	4.1	4.7	*5.1*	*4.6 - 5.8*
			T+O	£87.5m	£115m	£107m	£100m	£94m	£91m	£117m	£109m	£91m	*£85m*	*< £90m*
			Δ GW from Optimum	-0.4	2.6	2.0	1.6	1.1	-0.5	-1.1	-1.0	-0.4		
			Δ T+O from Optimum	£3m	£30m	£22m	£15m	£9m	£6m	£32m	£24m	£6m		
		GG5c	GW	7.3	9.9	9.4	9.0	8.6	7.2	6.4	6.5	7.6	*8.4*	*7.8 - 9.2*
			T+O	£156m	£148.5m	£143.5m	£139m	£137m	£160m	£212m	£201m	£147m	*£136.5m*	*< £141.5m*
			Δ GW from Optimum	-1.1	1.5	1.0	0.6	0.2	-1.2	-2.0	-1.9	-0.8		
			Δ T+O from Optimum	£20m	£12m	£7m	£3m	£1m	£24m	£76m	£65m	£10m		
B8	93	GG5a	GW	8.7	12.1	11.5	11.0	10.5	8.4	8.3	8.2	8.7	*7.3*	*6.8 - 8.5*
			T+O	£82m	£112.5m	£107.5m	£102.5m	£97.5m	£80.9m	£80m	£79m	£83m	*£76m*	*< £81m*
			Δ GW from Optimum	1.4	4.8	4.2	3.7	3.2	1.1	1.0	0.9	1.4		
			Δ T+O from Optimum	£6m	£37m	£32m	£27m	£22m	£5m	£4m	£3m	£7m		
		GG5c	GW	9.4	12.5	12.0	11.5	11.1	9.1	9.0	8.9	9.5	*8.7*	*7.4 - 9.7*
			T+O	£89m	£117m	£112m	£107m	£103m	£88m	£88m	£87m	£91m	*£86m*	*< £91m*
			Δ GW from Optimum	0.7	3.8	3.3	2.8	2.4	0.4	0.3	0.2	0.8		
			Δ T+O from Optimum	£3m	£31m	£26m	£21m	£17m	£2m	£2m	£1m	£5m		
B9	155	GG5a / GG5c	GW	9.3	12.6	12.1	11.6	11.1	9.2	8.4	8.1	8.3	*7.3*	*6.7 - 8.3*
			T+O	£146m	£195m	£187m	£179m	£172m	£144m	£135m	£131m	£133m	*£127m*	*< £132m*
			Δ GW from Optimum	2.0	5.3	4.8	4.3	3.8	1.9	1.1	0.8	1.0		
			Δ T+O from Optimum	£19m	£68m	£60m	£52m	£45m	£17m	£8m	£4m	£6m		
B15	60	GG5a / GG5c	GW	6.7	9.0	8.6	8.2	7.8	6.5	6.2	6.4	6.2	*8.4*	*7.7 - 9.5*
			T+O	£113m	£55m	£53m	£53m	£56m	£150m	£188m	£165m	£198m	*£53m*	*< £58m*
			Δ GW from Optimum	-1.7	0.6	0.2	-0.2	-0.6	-1.9	-2.2	-2.0	-2.2		
			Δ T+O from Optimum	£60m	£2m	£0m	£0m	£3m	£97m	£135m	£112m	£145m		

- x: 0 < x < £5m
- x: £5m < x < £15m
- x: x > £15m

System Boundaries



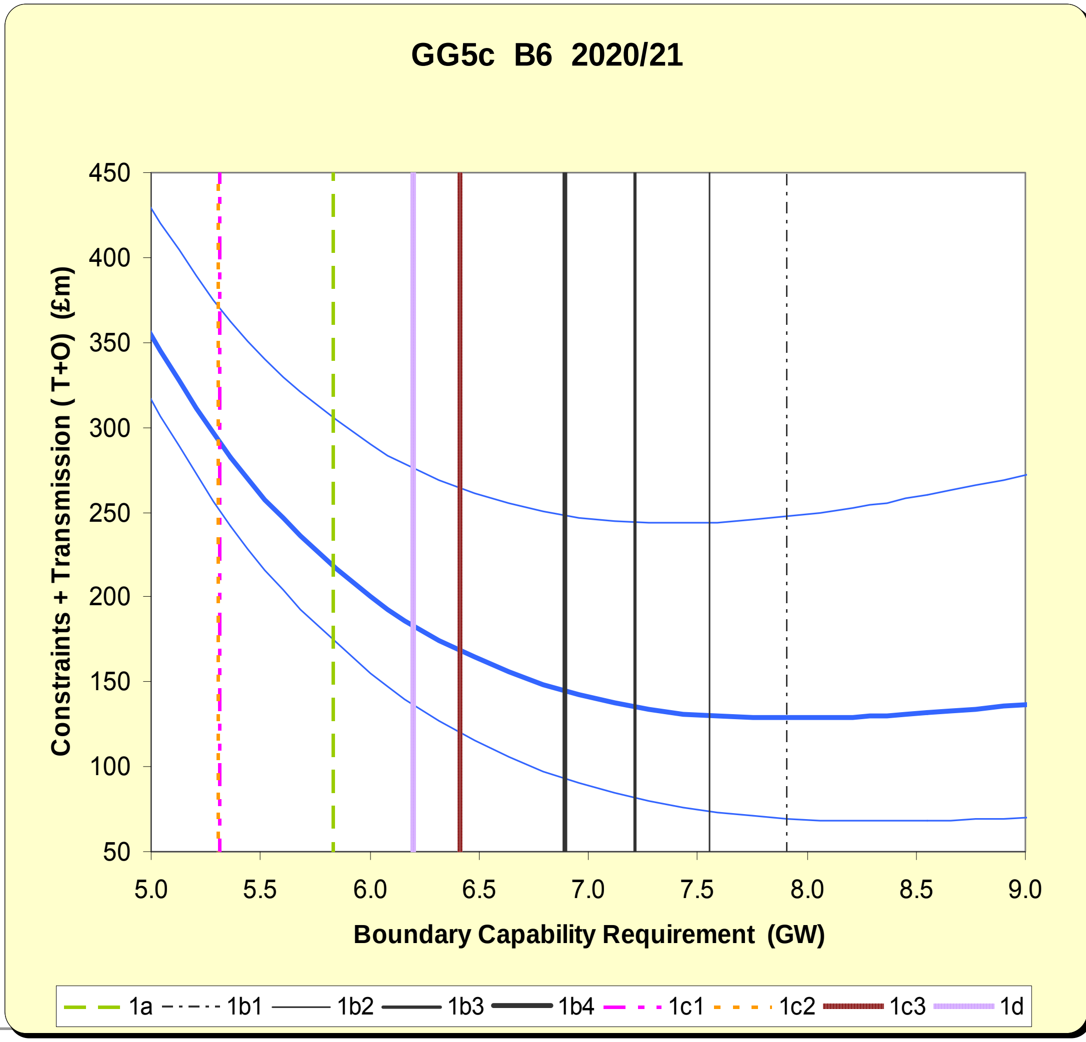
3. Assessment of Results — B4



- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B4

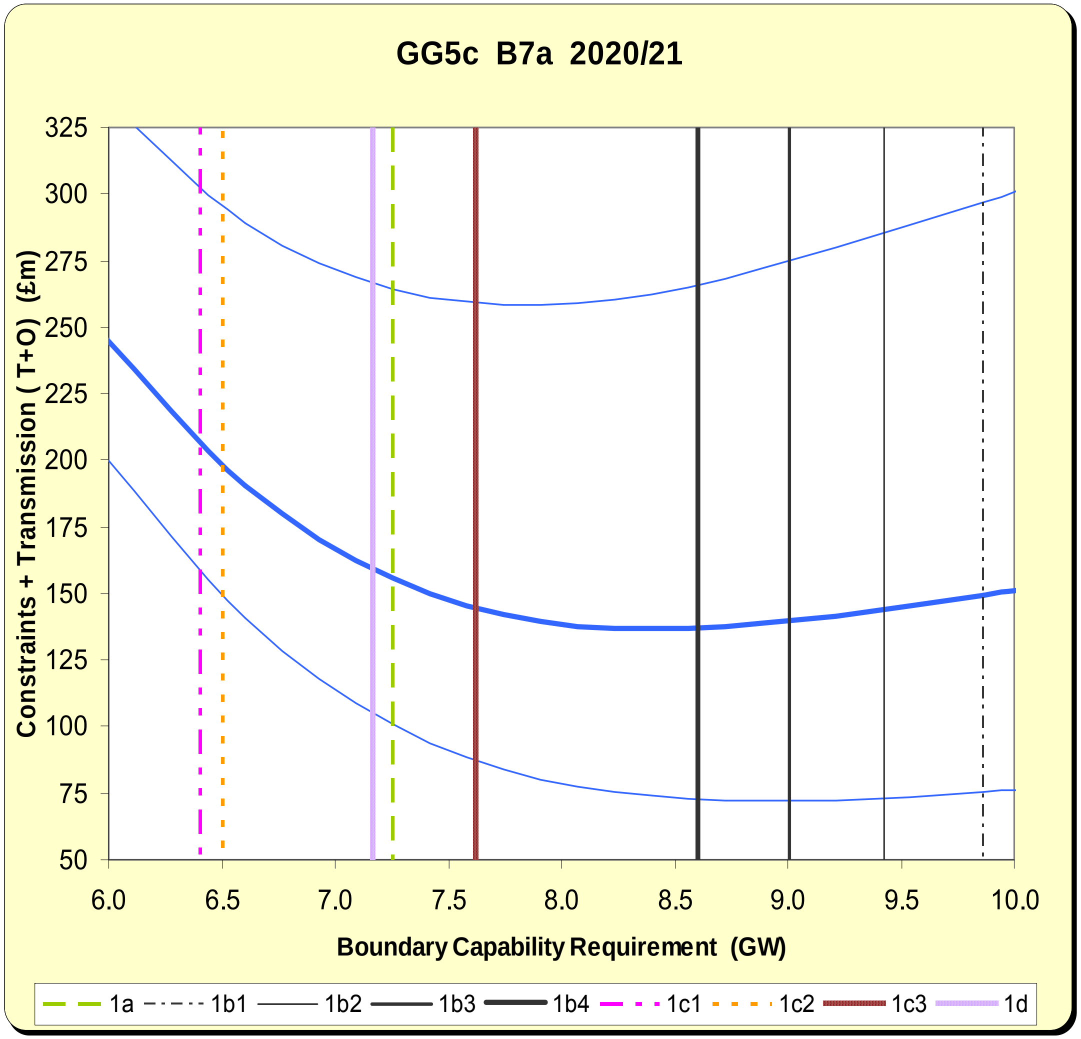
- Background GG5c 2020

3. Assessment of Results — B6



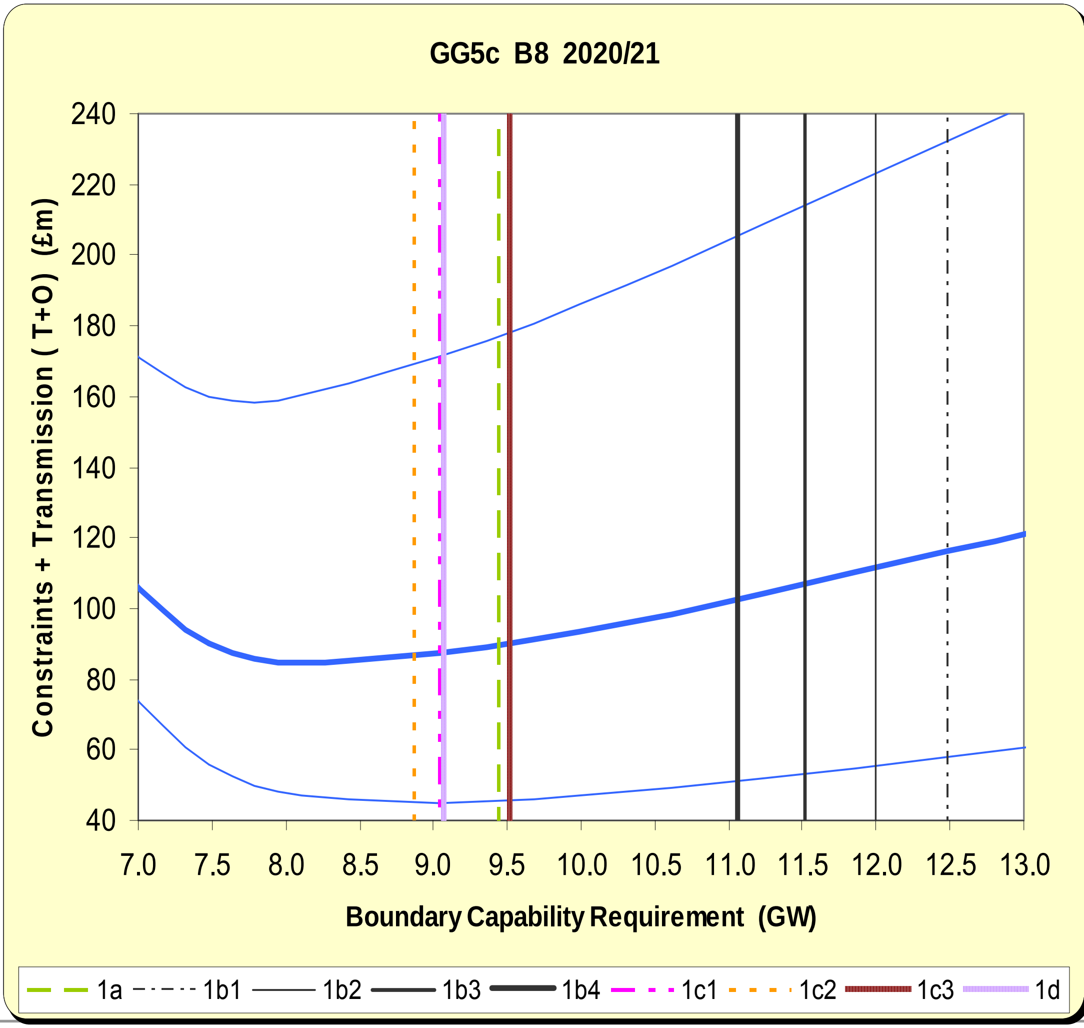
- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B6
- Background GG5c 2020

3. Assessment of Results — B7a



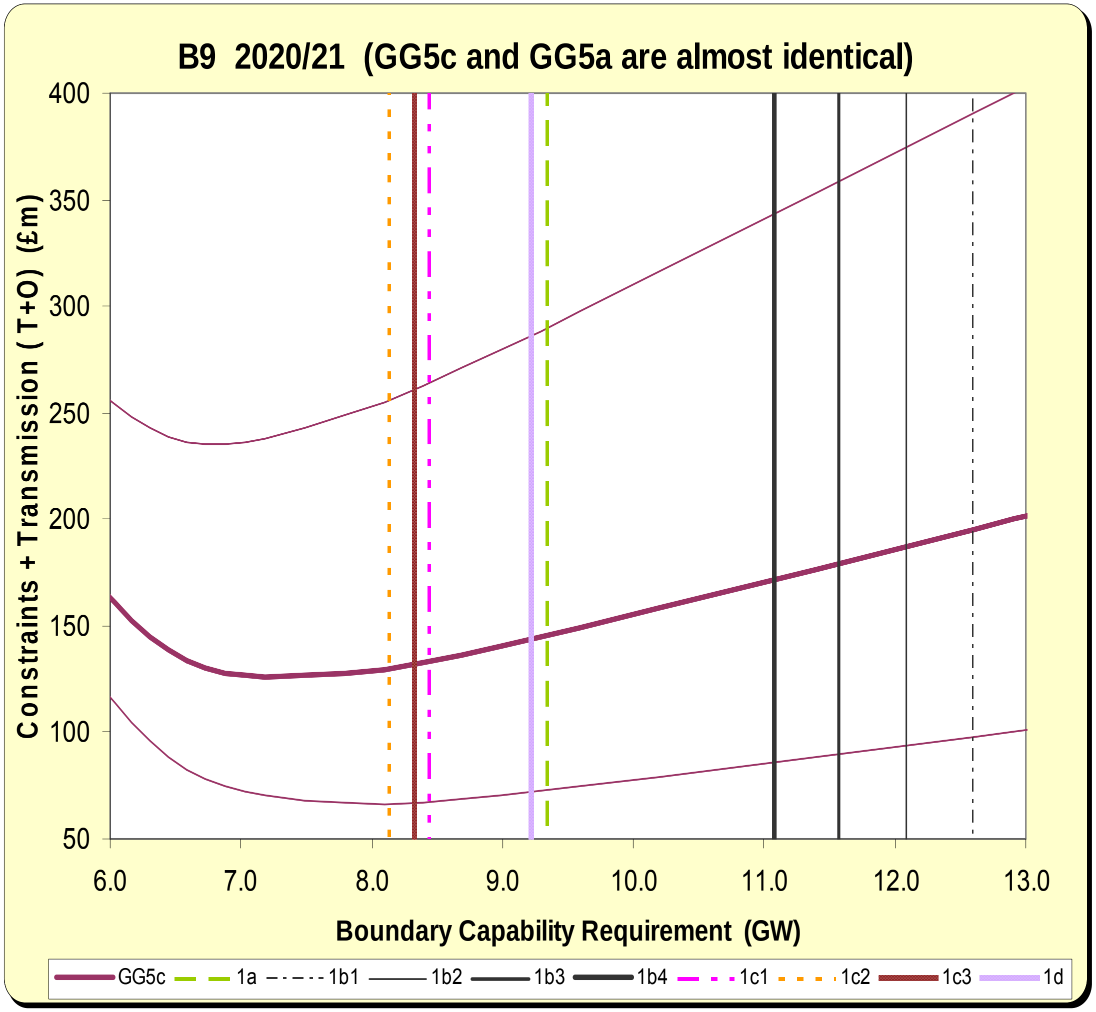
- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B7a in 2020/21
- Backgrounds GG5c

3. Assessment of Results — B8



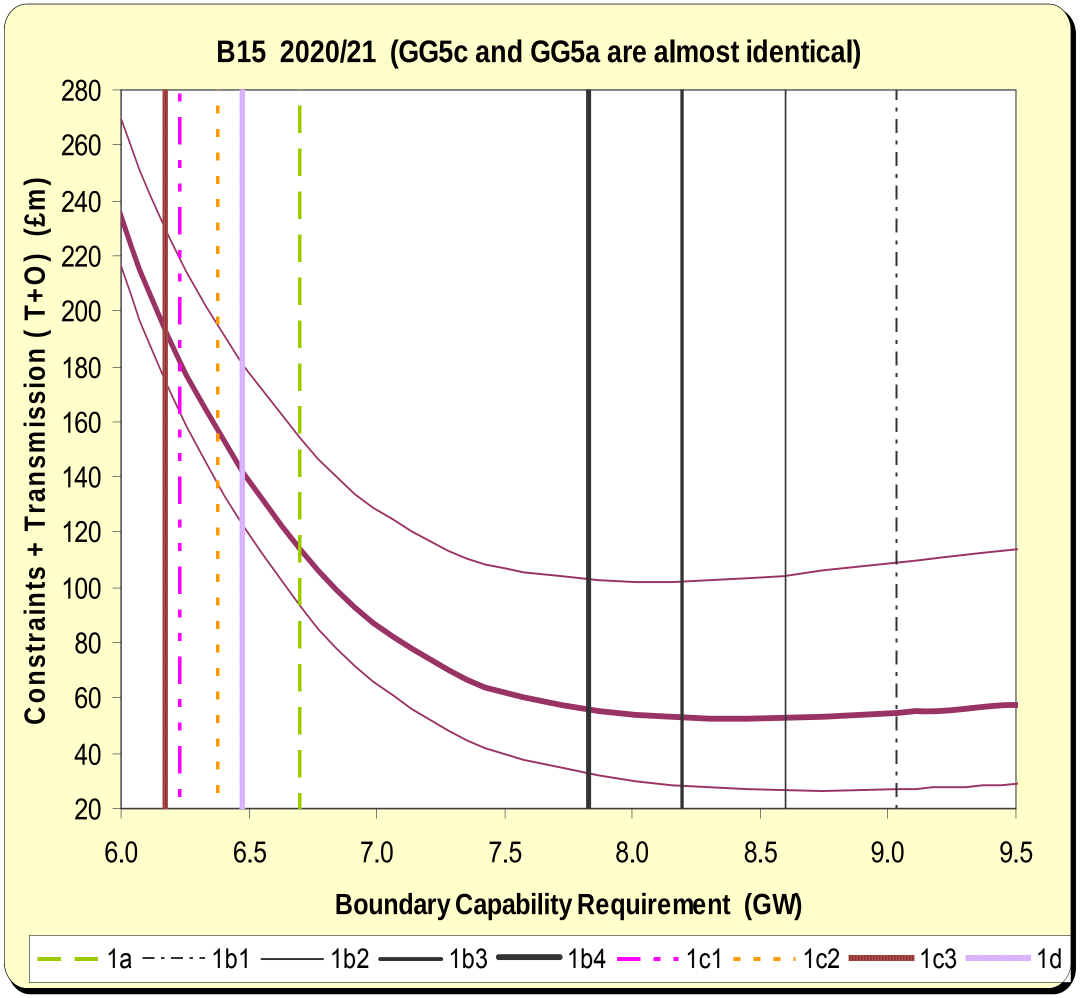
- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B8 in 2020/21
- Backgrounds GG5c

3. Assessment of Results — B9



- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B9 in 2020/21
- Backgrounds GG5c and GG5a are close to identical

3. Assessment of Results — B15



- Points 1a 1b1 1b2 1b3 1b4 1c1 1c2 1c3 and 1d shown for boundary B15 in 2020/21
- Backgrounds GG5c and GG5a are close to identical

4. Assessment of Results

Broadly:

- For ‘small’ export boundaries B4 B6 B15, any of 1b1-1b4 look best
- For the large boundaries B7a B8 B9, 1a, 1d or 1c1-1c3 look best

Sensitivities

- Backgrounds: we have covered quite a wide range of backgrounds:
  - 10% Wind in 2015; 30% Wind in 2020 and 40% Wind in 2030
  - Strong Scottish bias for Wind in GG5c and strong English bias in GG5a
- Boundaries: we have covered the major types on GB system 2015-2030
  - This study never intended to look at the import boundaries
- Deterministic Rules: there are no sensitivities, once one fixes the rules
- Economic Measuring Stick: endless sensitivities are possible
  - Halving and Doubling the transmission price is powerful. It also covers the case of doubling and halving the constraint price
  - Expect that #outage-weeks; Wind load factor; Wind correlation; etc would be minor
  - Flipping Gas and Coal in merit order might be interesting

Conclusions

- The method appears reasonably robust against possible sensitivities
- The ‘regrets’ of greater Constraints O if one under-builds, are greater than the regrets of greater Transmission T if one over-builds
- Minded to propose 1c3 or a variant of this

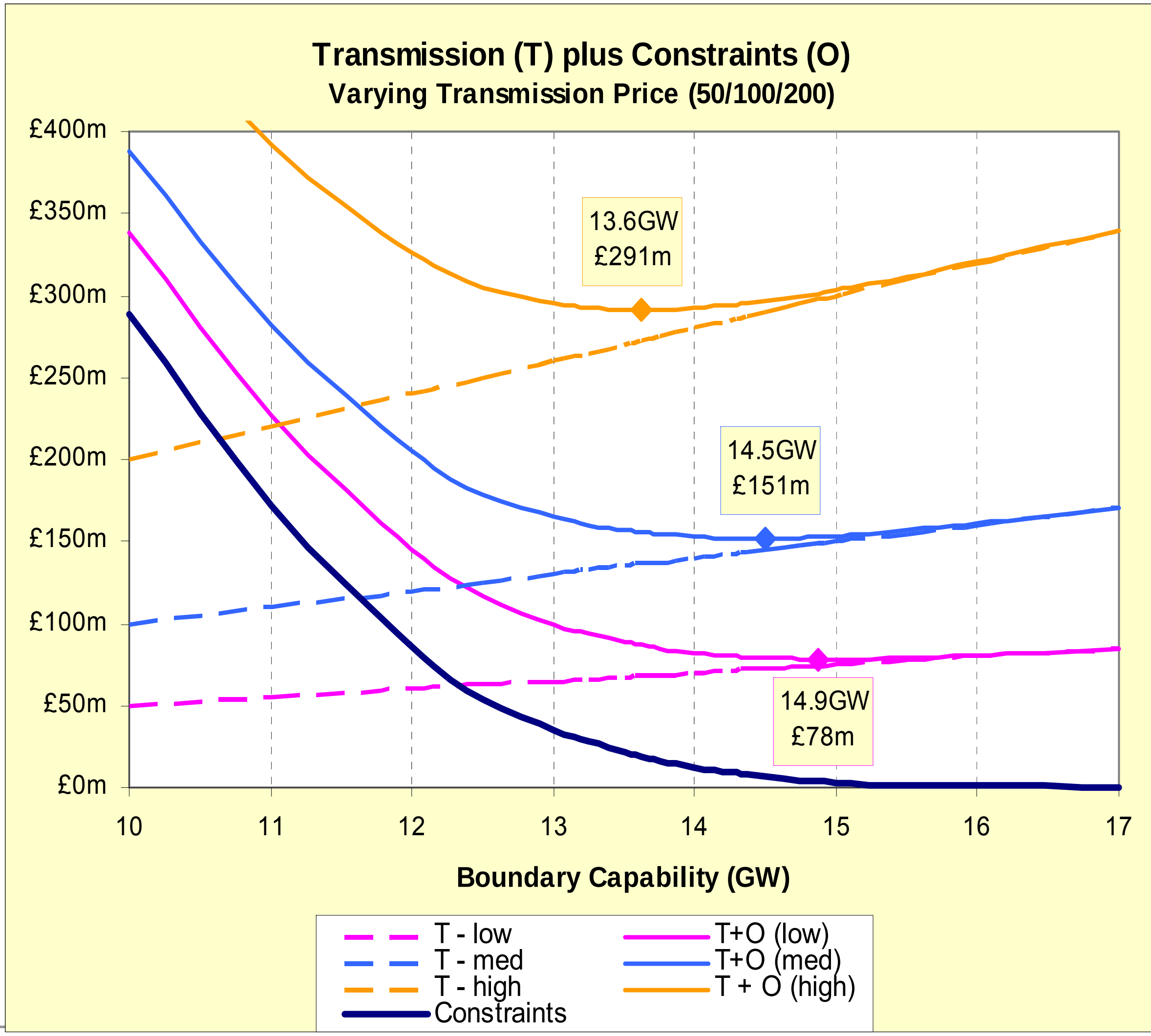
Ongoing Assessment

- Different A_T factors within- fuel-type, eg for Base_Gas and Marg-Gas?
- Refined treatment of Interconnection Allowance? (e.g. varying by boundary according to generator categorisation uncertainty)
- Treatment of Interconnectors
  - Annual statement of 'generator-like' / floating / 'demand-like'
  - Then, generator-like interconnectors are scaled, along with conventional generation
- Wind DSF = 50% / 60% / 70%
  - 60% is current thinking, because it calibrates against the economic measuring stick

Humber – Humber group capacity by 2020/21 (MW)

Fuel	Plant	Humber
Wind_off	Humber Gateway	300
	Round 3 - Dogger Bank / Hornsea	12,800
	Westernmost Rough	240
Wind_off Total		*13,340*
Base_Gas	Immingham 1	719
	Immingham 2	499
	Saltend	1,100
Base_Gas Total		*2,318*
Biomass	Brigg - Biofuel	136
	Stallingborough	100
Biomass Total		*236*
Marg_Gas	Keadby No.1	710
	Killingholme 2	665
	South Humberbank 1&2	1,285
Marg_Gas Total		*2,660*
Aux GT / Main GT	Keadby No.1 (black start)	25
Aux GT / Main GT Total		*25*
Grand Total		18,579

Humber - analysis



- Three transmission prices (50 / 100 / 200 £/MW.km)
- T linear; O approx. quadratic
- T+O curves plotted
- Optimum reinforcement at T+O curve minimum

Humber - results

- Base and sensitivity results summary
- Optimum reinforcement points shown (GW)

Capability		Transmission Price (£/MW.km)		
		high	medium	low
		200	100	50
Base		**13.6**	**14.4**	**14.9**
Wind	+4GW	17.5	18.5	19.0
	+2GW	15.5	16.5	16.8
	-2GW	11.5	12.5	13.0
Base_gas	+2GW	15.0	15.8	16.5
	-1.8GW	12.8	13.3	14.0
Marg_gas	+2GW	13.8	14.5	15.0
	-2GW	13.5	14.3	15.0

Humber - conclusion

In this extreme case, we build

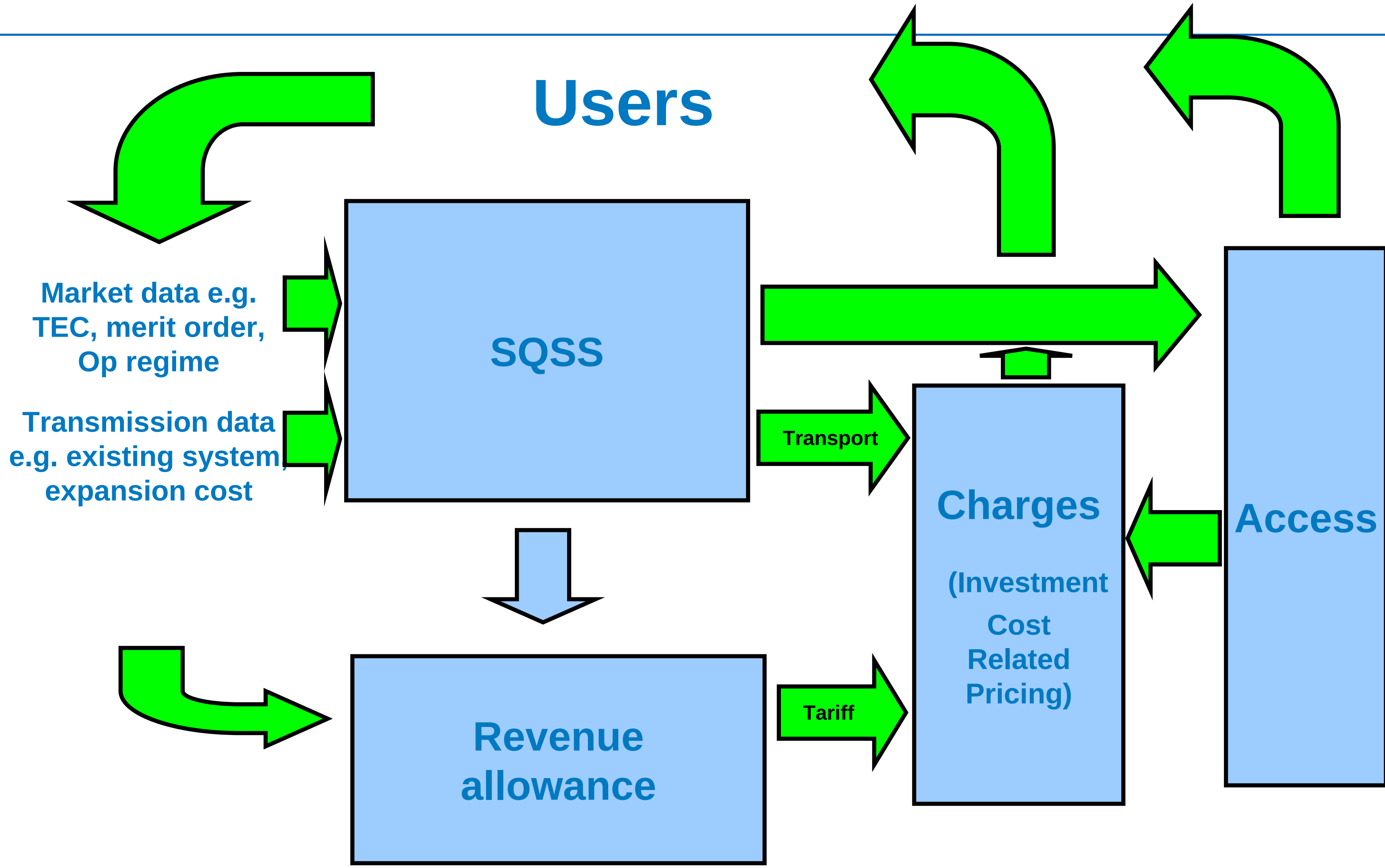
- **1GW of transmission for 1GW Wind**
- **0.7GW of transmission for 1GW Base_Gas**
- **….And zero for Marg_Gas**

i.e. the wind drives more transmission capacity than conventional generation

Charging and Access Linkage

- Signals with Use of System tariffs are based on Investment Cost Related Pricing methodology
  - ‘cost reflective’ ; effective competition
- Application of SQSS determines the level of investment
- Access rights have an impact on assessment of investment
  - Wind access implicitly restricted due to fuel source
  - Convention plant has potential to use system 24/7
- Consideration of further issues
  - Stability, predictability, transparency, simplicity

Interactions



Access Products

- Investment process relies on industry data / assumptions
- TAR investigated how these could be established
  - Approach is Connect and Manage
  - Manage can include development of products
  - Products provide information
- Should / can data be effectively ‘procured’ from the industry?
  - CBA requirements?
  - Access products?
    - User commitment
    - Sharing
    - Fixed buyback

Charging Consultation Process

- National Grid will publish a consultation on consequential charging arrangements consequential to the proposed SQSS change
- The SQSS analysis for the wind will be used as a basis of development of wind charging arrangements

Questions

- Some questions for you to consider/discuss…
  - Are you in favour of the dual-criterion approach?
  - Do you support the use of a deterministic wind-integration criterion?
  - How should marginal/baseload plant be considered? Is it appropriate to differentiate between generators of the same fuel type (e.g. which gas/coal generators are displaced by wind generation when it is plentiful)?
  - How to select input parameters for the cost-benefit derived measuring stick (e.g. ‘theoretical’ or ‘observed’ bid and offer pricing)?